Aquatic invertebrates of the Hutt River and Hutt Lagoon catchments, Western Australia

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The Hutt River and Hutt Lagoon catchments lie along the coast of the mid-west region of Western Australia. An earlier study suggested they were amongst a set of catchments that efficiently represent salinity-threatened biota in the agricultural southwest of the State. Several of the other catchments in that set have been included in a program to protect their biodiversity assets. This paper reports on the diversity and biogeographic affinities of the aquatic invertebrate fauna of the combined Hutt catchments. We also assess the extent to which this fauna is complementary to those of other catchments and wetland suites managed for conservation in southern Western Australia. A total of 249 invertebrate species were collected from these catchments. This fauna includes species that have primarily northern Australian distributions and species that are more common in the higher rainfall southwest, demonstrating that the catchments lie within a zone of north–south faunal transition. It is unlikely that any individual species are unique to these catchments. However, the catchments do support a fauna that is dissimilar in composition to faunas of other wetland suites and catchments of the agricultural southwest for which there is similar information. Faunal composition varied greatly between the wetland habitats surveyed, with the freshwater springs and creeks representing particularly important habitats within the region. Six groups of wetlands are recognised based on the composition of their invertebrate communities and these are used as a framework for discussing conservation issues.

KEYWORDS: aquatic invertebrates, conservation, Hutt Lagoon, Hutt River, rivers, springs, Western Australia, wetlands.

INTRODUCTION

Aquatic biodiversity in the Western Australian Wheatbelt was surveyed by Pinder *et al.* (2004) and Lyons *et al.* (2004) as part of a comprehensive survey of the region (Keighery *et al.* 2004). This is one of a number of large-scale surveys that have greatly increased knowledge of the State's aquatic biodiversity over the last two decades (Davis *et al.* 1993; Halse *et al.* 2000a; Horwitz 1997; Pinder *et al.* 2004, 2010a). Such surveys have a relatively sparse distribution of study sites, reflecting resource constraints in relation to the large areas surveyed. Smaller catchments and wetland areas identified as potentially high conservation value, sometimes as a result of the larger surveys (McKenzie *et al.* 2000; Commonwealth of Australia and the State of Western Australia 1999; Walshe *et al.* 2004), frequently require more intensive studies for local conservation planning. In the Wheatbelt, data from the regional survey were used by Walshe *et al.* (2004) to identify a set of catchments that 'efficiently represented [salinity threatened] diversity'. Several of those catchments have now been included in a 'Natural Diversity Recovery Catchment Program' (http://www.dec.wa.gov.au/content/view/449/949/) that aims to manage catchments for protection of their natural values. As recommended by Walshe *et al.* (2004), surveys and/or monitoring have been undertaken at some of the Wheatbelt wetlands to provide biodiversity data for local conservation planning (Aquatic Research Laboratory 2009; Cale 2008; Department of Environment and Conservation 2006). This paper reports on a survey of aquatic invertebrates in another of the Walshe *et al.* (2004) catchments—the Greenough (Hutt) in the mid-west of Western Australia. This survey joins a growing list of studies of catchments or wetland complexes that are providing an understanding of fine-scale aquatic biodiversity patterning and filling gaps in the larger surveys (Edward *et al.* 1994; Halse *et al.* 1996, 1998, 2000b; Pusey & Edward 1990; Stewart 2009; Storey *et al.* 1993, 2011; Timms 2009).

The objectives of this paper are to (i) describe the aquatic invertebrate communities of the Hutt River and Hutt Lagoon catchments; (ii) investigate the biogeographic affinities of the fauna; (iii) assess the extent to which the catchments support a fauna already represented in other wetlands and catchments managed for conservation in the southwest agricultural zone; and (iv) identify priorities for aquatic invertebrate conservation in these catchments.

STUDY AREA

The Walshe *et al.* (2004) Greenough (Hutt) catchment incorporates four of the Greenough Basin sub-catchments. These are the two sub-catchments of the Hutt River (shown merged on Figure 1), the northernmost sub-catchment of the Greenough Coastal catchment (labelled as the Hutt Lagoon catchment on Figure 1) and a small northern sub-catchment of the Bowes River Catchment. Only the first three of these sub-catchments are included in our study (Figure 1) and they are jointly called the Hutt catchments in this paper. These are located on the mid-west coast about 75 km north of

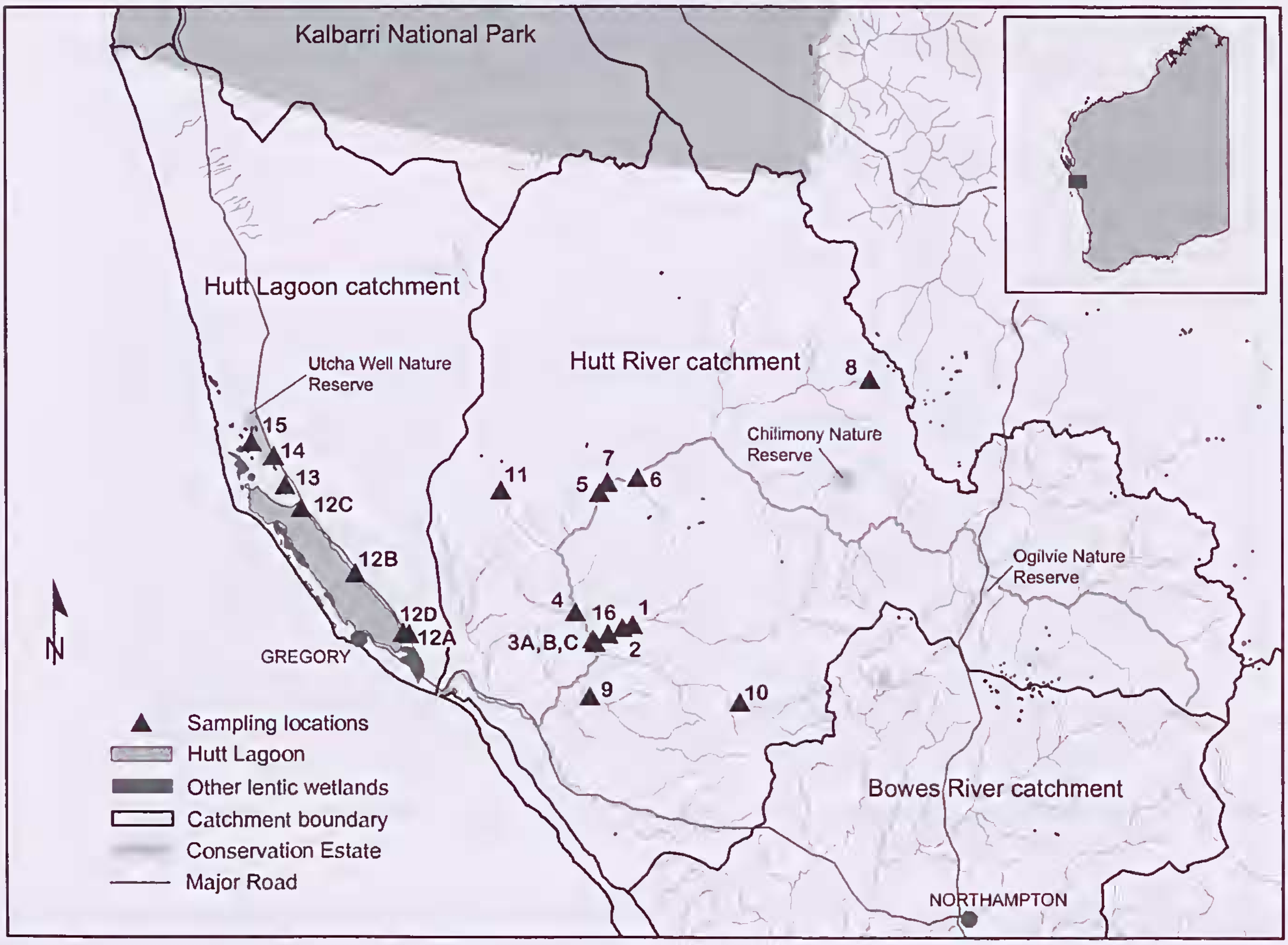

Figure 1. Map of the Hutt catchments showing locations of sampled sites and boundaries of the Hutt River and Hutt Lagoon catchments.

Geraldton and occupy about 200 000 ha (8.9%) of the Geraldton Hills IBRA subregion (Australian Government 2004). The 'mid-west' referred to in this paper is that semiarid to arid region of the State between the more temperate southwest and the Pilbara region in the north extending inland from the coast towards the desert regions. The southwest of this area overlaps with the northern extent of region of dryland agricultural zone known as the Wheatbelt.

The Hutt River catchment is dominated by the 60 km-long main channel of the Hutt River. In its upper catchment, low gradient creeks lie on a 220–260 mASL plateau and these are mostly salinised. On this plateau there are also numerous seasonal secondarily saline wetlands. The middle and lower parts of the catchment are more dissected and include perennial spring-fed tributaries, many of which are fresh. Rainfall-dominated flows (primarily in winter and spring) carry high salt loads from the upper catchment. In summer, low-salinity groundwater discharge usually becomes the dominant source of water and the river then has lower salinity. Hutt Lagoon is a 12 km long x 2 km wide, shallow (<1 m) hypersaline evaporative birrida. This is the old estuary of the Hutt River, now naturally isolated from the ocean (Arakel & Moulton 1986) but receiving marine water via subsurface flows due to the lagoon lying below sea-level. On the low-lying flats north of the lagoon are numerous swamps and marshes, including Utcha Swamp. Hutt Lagoon and Utcha Swamp are listed in the Directory of Important Wetlands in Australia (Environment Australia 2001).

The region has mild wet winters and hot dry summers. Mean annual rainfall increases from about 350 mm at Binnu, just east of the Hutt River catchment, to 405 mm at Lynton (near Gregory) on the coast. Rainfall was well below average in 2007 (222 mm at Binnu and 212 mm at Lynton) but summer 2007/08 rainfall (86.8 mm) was much higher than average (25.1 mm), falling mostly on 11 December 2007 and 21 February 2008. The higher than average summer rainfall meant that the Hutt River did not freshen up in summer, as it normally does when flow from the freshwater springs becomes dominant.

Land use in the Geraldton Hills subregion is primarily dryland agriculture (65.8%), with lesser areas of conservation (13.8%), grazed native pastures (13.2%) and other crown lands (6.5%) (Desmond & Chant 2002). Over 98% of the area in this subregion's conservation estate is contained in two reserves: Kalbarri National Park (183 004 ha) and Wandana Nature Reserve (54 821 ha), both of which are entirely outside the Hutt catchments. Only 0.25% of land within the Hutt catchments is in conservation estate: Chilimony Nature Reserve, Nature Reserve 12657 and Utcha Well Nature Reserve, the latter fragmented into several parcels (Figure 1). Clearing of native vegetation for agriculture has been extensive within the catchments and has resulted in altered groundwater and surface water hydrology and associated secondary salinisation, especially in upper parts of the Hutt River catchment. Stock access and feral pig activity in the Hutt River channel and riparian zone have contributed to weed invasion, bank erosion, siltation of streams and poor water quality in the Hutt River (Department of Environment 2005).

In a previous invertebrate survey, Pinder *et al.* (2004) sampled aquatic invertebrates at four sites in the Hutt catchments in July 1999: Yarder Gully, Yerina Spring, Hutt Lagoon and Utcha Swamp. All of these wetlands were re-sampled during the present project, but not necessarily at the same location (Table 1). Hutt Lagoon was also sampled in October 2008 by Nowicki *et al.* (2009). These data are included in our analyses.

METHODS

Study sites

Twenty-one sites have been sampled in total (Table 1). Eighteen sites were sampled for this survey, some of which were also sampled by Pinder *et al.* (2004), and three additional sites were sampled during previous or subsequent studies (Nowicki *et al.* 2009; Pinder *et al.* 2004). In the Hutt River catchment, sites were located along the main channel of the middle to lower Hutt River (sites 3A and C and sites 4–6), some of the main tributaries (sites 2, 9, 10 and 16) and some of the springs and seepages feeding into the river or tributaries (sites 1, 3B, 7, 8 and 11). In the Hutt Lagoon catchment, the main body of the lagoon was sampled at sites 12A to 12C, an area of low salinity seepage on the eastern shore of the lagoon was sampled at site 12D and some of the wetlands north of the lagoon were sampled (sites 13–15). Gaps in sampling include small playas and saline streams in the upper Hutt River catchment, wetlands in dunes to the west of Hutt Lagoon and ephemeral creeks draining the hills east of Hutt Lagoon.

Most sampling was carried out in spring (4 samples in 1999, 17 samples in 2007 and 1 sample in 2008). Three sites (3A, 3C and 4) plus one extra site (3B) were sampled in February 2008. This gives a total of 26 samples (Table 1). The February 2008 sampling was undertaken to examine whether the lower flow and salinity expected in the Hutt River at that time of year (due to flows becoming dominated by the fresher spring-fed tributaries), resulted in altered community composition compared to spring.

Water quality

Electrical conductivity, pH and water temperature were measured in the field using a WTW WP-81 meter. Flow was measured using a Hydrological Services OSS-PC1 current meter, except where water was too shallow and then flow was estimated by timing the movement of a neutral buoyancy object (generally a eucalypt nut). At least 1000 mL of water was passed through a glass microfibre filter paper and the paper retained and frozen for analysis of chlorophyll and the filtrate was passed through a 0.45 μm pore filter paper and frozen for analysis of total filterable nitrogen and phosphorus. Unfiltered water was collected for analysis of colour, hardness, alkalinity, ionic composition and turbidity.

Invertebrates

On each sampling occasion, two invertebrate samples were collected: a plankton sample using a net with 50 μm mesh to sweep through the water column and gently through sparse vegetation and one benthic sample using a net with 250 μm mesh to sample the dominant habitats (*e.g.* open water, detritus, vegetation and substrates). Each sample involved sweeping for a total of about 50 m (usually not contiguous). The benthic samples were elutriated in the field to remove heavier inorganic material, leaves and woody debris were washed and discarded and then the sample was preserved in ethanol. The plankton sample was preserved in buffered formalin. The entire contents of each sample were sieved and sorted in the laboratory and representatives of each taxon seen during sorting were removed. Invertebrates were identified to species level where possible.

Data analysis

To assess robustness of cluster groupings several methods were used (Legendre & Legendre 1998). Non-hierarchical k-means clustering (into six groups) was performed using the 'pam' function in the R package 'Vegan' (Oksanen *et al.* 2008; R Development Core Team 2011) and agglomerative clustering was performed using the 'agnes' function in the R package 'Cluster' (Maechler *et al.* 2007), with average, complete and flexible linkage methods, the latter with beta = -0.1. Co-phenetic variation (using the 'cophenetic' and 'correlation' functions in R) was used to investigate how well the clustering represented original inter-sample distances. The function 'simprof' in the R package 'Clustsig' (Whitaker & Christman 2010) was used to identify significant clusters in dendrograms.The Chao2 species richness estimator (Chao 1987) in Estimate S (Colwell 2006) was used to estimate total species richness in the Hutt catchments.

To compare community composition between Hutt catchment wetlands and wetlands in other Walshe *et al.* (2004) catchments, all available data from these catchments were combined in a non-metric multidimensional scaling (nMDS) ordination using Primer-E Ltd (2008). For this analysis, some manipulation of the matrix was required where the level of taxonomic resolution and nomenclature used for undescribed species was irreconcilable between the Buntine–Marchagee dataset (Aquatic Research Laboratory 2009 and reports therein) and the datasets for other recovery catchments: Toolibin (Halse *et al.* 2000b), Drummond (Cale 2005 and unpublished data), Bryde (Cale *et al.* 2004, 2008) and Warden (Pinder *et al.* 2010b and unpublished data).

RESULTS

Water physico-chemistry

Table 2 contains the water chemistry data for all samples. Of the 22 samples collected in spring 1999, 2007 or 2008,

Table 1 List and descriptions of sites sampled in the Hutt catchments.

Site no.	Site name	Date(s) sampled	Grid reference (50J)	Description
1	Yarder Gully headwater spring	11 Sep 2007	6879876 247324	Spring running south of main creek line of Yarder Gully with seepage areas, shallow trickling water and muddy pools amongst sedges and ferns
2	Yarder Gully	11 Sep 2007	6879663 246685	Reach of Yarder Gully flowing through dense sedges
3A	Hutt River at Yarder Gully confluence	12 Sep 2007 25 Feb 2008	6878960 244831	Hutt River immediately upstream and including Yarder Gully confluence
3B	Hutt River rock pool seepage	12 Sep 2007	6878960 244831	Shallow rock pools capturing seepage which flows into the Hutt River just down stream of the Yarder-Hutt confluence.
3C	Hutt River downstream of Yarder Gully	25 Feb 2008	6878740 244987	Hutt River immediately downstream of Yarder Gully confluence
4	Hutt River on Glenorie Station	11 Sep 2007 25 Feb 2008	6880697 243788	Braided reach downstream of two seepages from eastern bank
5	Hutt River south of Gregory Spring	13 Sep 2007 26 Feb 2008	6888124 245272	Reach with intact vegetation on both sides and passes over bedrock and silty areas. Downstream of seepage from Gregory Spring
6	Hutt River north of Gregory Spring	13 Sep 2007	6889103 247628	Silty reach upstream of Gregory Spring
7	Gregory Spring	13 Sep 2007	6888774 245773	A groundwater seepage area with sedges and small pools up to 3 cm deep and (when wet) with water trickling south to the adjacent Hutt River
8	Feast Soak	14 Sep 2007	6895238 262202	A sedge-filled soak with small areas of shallow open water. The resulting creek line is highly degraded but the spring itself is in somewhat better condition
9	Harry Spring Creek	14 Sep 2007	6875374 244637	A heavily wooded reach of a freshwater creek flowing north from Harry Spring. Channel heavily silted but includes areas of bedrock and overhanging vegetation
10	Creek next to Swamp Road	12 Sep 2007	6875065 254012	Narrow deeply incised creek adjacent to Swamp Road
11	Yerina Spring	14 Sep 2007 22 July 1999	6888276 239110	Sedgeland groundwater seepage with wettest areas amongst *Typha* or where a roadway impedes seepage (site SPS190 of Pinder *et al*. 2004)
12A	Hutt Lagoon site A	15 Sep 2007	6879372 233000	An area of low salinity groundwater seepage in sedges on SE shore of lagoon
12B	Hutt Lagoon site B	15 Sep 2007	6883079 230016	Eastern edge of main water-body of lagoon
12C	Hutt Lagoon site C	09 Oct 2008	6887130 226585	North-eastern corner of lagoon (site RCM028 of Nowicki *et al*. 2009)
12D	Hutt Lagoon site D	21 Jul 1999	6879372 232800	South-eastern end of lagoon (site SPS189 of Pinder *et al*. 2004)
13	*Baumea*/*Cyperus* fringed swamp	15 Sep 2007	6888618 225663	Hyposaline wetland with areas of open water surrounded by very dense stands of *Baumea articulata* and *Cyperus laevigatus*
14	Utcha Swamp	10 Sep 2007 21 July 1999	6890446 224944	Swamp with dense stands of submerged macrophytes and severe *Typha* encroachment (SPS188 of Pinder *et al*. 2004)
15	Sedge fringed flats north of Hutt Lagoon	15 Sep 2007	6891302 223555	Shallow sedge-fringed subsaline flats north of Hutt Lagoon
16	Yarder Gully	23 Jul 1999	6879280 245787	Braided open reach of Yarder Gully (site SPS192 of Pinder *et al*. 2004)

Table 2 Environmental data for wetland sites sampled in the Hutt catchments

Site no.	Date	Cluster group	Depth of invertebrate sample (cm)	pH	Total filterable nitrogen (μg/L)	Total filterable phosphorus (μg/L)	Nitrite/Nitrate (μg/L)	Chlorophyll (μg/L)	Water temperature (°C)	Maximum flow (m/s)	Turbidity (NTU)	Colour (TCU)	Conductivity (μs/cm)	TDS (g/L)	Alkalinity (mg/L)	Hardness (mg/L)	Silica (mg/L)	Na^+ (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	K^+ (mg/L)	Cl^- (mg/L)	HCO_3^- (mg/L)	CO_3^{2-} (mg/L)	SO_4^{2-} (mg/L)
1	11 Sep 2007	1	10	7.38	330	30	5	4.5	16.8	0	61	73	1298	0.68	28	120	49	173	7.8	23.4	8.1	335	34	0.5	47.1
3B	12 Sep 2007	1	40	6.2	3600	130	5	11	15.5	0	11	590	13420	8.80	120	1100	31	2160	64.1	240	55	4220	146	0.5	403
9	14 Sep 2007	1	45	7.09	870	10	120	10	17.5	45	53	52	4600	2.60	33	460	25	675	35.3	91.3	15.6	1270	40	0.5	155
10	12 Sep 2007	1	20	7.31	390	10	5	6	19.6	1	0.9	37	4540	2.50	33	460	43	664	33.8	89.9	10.8	1340	40	0.5	112
11	14 Sep 2007	1	10	6.78	6400	30	4400	8.5	18.5	0	1.3	0.5	1444	0.88	35	90	82	242	6.2	18.1	3.4	379	43	0.5	89.4
11	22 Jul 1999	1	20	6.16	670	10	10	2.5	15.3	0	4.9	310	1055	1.50	113	260	57	480	19	51	13	720	137	1	105
2	11 Sep 2007	2	20	6.94	450	10	130	4.5	16.7	5	4.2	9	2310	1.10	35	200	52	334	13.1	39.9	5.7	631	43	0.5	48
3A	12 Sep 2007	2	20	6.2	580	10	5	3.5	15.5	45	11	78	6080	3.40	75	580	42	935	36.6	118	19	1640	92	0.5	168
3A	25 Feb 2008	2		6.52	1500	5	10	32	24.4	0	40	160	11430	6.40	110	1400	41	1990	90.2	274	58.5	3410	134	0.5	391
3C	25 Feb 2008	2		7.25	250	20	30	2	21.9	0	4.9	30	1943	1.10	40	200	62	312	12.9	40.8	7.4	543	49	0.5	31.7
4	11 Sep 2007	2	40	7.44	760	10	10	7.5	13.4	17.6	5.9	75	6110	3.30	83	570	45	926	35.8	117	18.3	1590	101	0.5	169
4	25 Feb 2008	2		7.04	400	10	5	5	31.3	0	2.9	8	3860	1.90	55	380	39	578	20.7	78.8	21.2	1040	67	0.5	52.9
5	13 Sep 2007	2	25	6.36	500	20	5	4.5	15.7	22	1.5	37	6910	3.70	70	690	56	1100	41.4	142	20.6	1980	85	0.5	167
5	26 Feb 2008	2		7.44	510	10	5	3.5	23.2	0	1.4	8	6840	3.50	120	700	44	1140	42.8	144	24.8	1910	146	0.5	75.7
6	13 Sep 2007	2	10	7.62	390	10	5	6	19.1	20	5.7	26	7400	4.10	88	710	54	1160	42.1	146	24.9	2090	107	0.5	177
16	23 Jul 1999	3	40	7.5	820	20	100	2	11.8	50	14	170	2820	1.30	93	230	34	441	19	45	13	700	113	1	65
7	13 Sep 2007	4	2	7.06	1100	20	5	10.5	20.8	0	1.6	180	7700	4.50	55	880	110	1120	52.1	181	26.2	2110	67	0.5	189
8	14 Sep 2007	4	5	6.67	1100	20	110	43.5	12.1	0	1.7	80	12880	8.00	50	1100	95	2060	44.8	244	42.1	3970	61	0.5	421
13	15 Sep 2007	5	30	8.38	660	20	5	7	19.1	0	0.25	26	7880	4.70	298	1100	47	1300	115	187	46.1	2290	308	27	378
14	10 Sep 2007	5	80	6.74	1100	50	5	6.5	20.9	0	7.2	88	2610	1.60	280	450	32	361	88.9	54.1	17.9	552	342	0.5	156
14	21 Jul 1999	5	120	7.55	680	30	10	2.5	17.3	0	1.3	93	3150	1.80	275	470	33	525	93	58	44	750	336	1	198
15	15 Sep 2007	5	40	9.72	1300	10	5	3.5	19.6	0	4.5	26	13090	8.80	80	1400	33	2210	140	266	77.2	3930	0.5	42	807
12A	15 Sep 2007	6	5	7.98	450	30	5	4.5	25.5	0	0.25	8	21000	15	505	2800	110	3790	173	573	134	6550	360	0.5	839
12B	15 Sep 2007	6	40	8.05	2300	40	5	5	24.7	0	29	17	180700	190	250	19000	38	51800	372	4450	1640	84800	305	0.5	7520
12C	09 Oct 2008	6	10	7.26	3300	20	5	2.5	32.1	0	31	210	228300	320	180	30000	-	123000	764	6750	2450	208000	220	0.5	1200
12D	21 Jul 1999	6	50	8	2200	10	10	3.5	18	0	3.9	2.5	170000	180	145	15000	6	69600	965	3000	1230	110000	177	1	6470

nine were fresh (0.68–2.6 g/L), 10 were hyposaline (3.4–15 g/L, most < 5 g/L) and three were hypersaline (180–320 g/L). The freshest sites were springs and spring-fed creeks (sites 1, 2, 9, 10 and 11) and the most saline was Hutt Lagoon (up to 320 g/L). The Hutt River was mostly low hyposaline (generally 3–7 g/L). In the three sites sampled in both spring 2007 and the following February, salinity was about the same in both seasons at site 5, lower in summer at site 4 and higher in summer at site 3A. Sites in the Hutt River catchment all had circum-neutral pH (6.2–7.6) whereas pH in Hutt Lagoon catchment wetlands were mostly alkaline (6.7–9.7).

All wetlands were NaCl dominated, with order of milliequivalent cation dominance being $Na^+>Mg^{2+}>Ca^{2+}>K^+$ for all wetlands except for one sample from the main body of the Hutt Lagoon (site 12B) which had $Na^+>Mg^{2+}>K^+>Ca^{2+}$ and Utcha Swamp (site 14) which had $Na^+>Mg^{2+}= Ca^{2+}>K^+$. Sodium represented a particularly high proportion of anions in Hutt Lagoon (site 12B) and Yerina Spring (site 14), compensated for by lower Mg^{2+} and Ca^{2+}.

Most sites had $Cl^->SO_4^{2-}>HCO_3^->CO_3^{2-}$ but three wetlands had $Cl^->HCO_3^->SO_4^{2-}>CO_3^{2-}$. The latter sites were the Hutt River downstream of Yarder Gully (site 3C), Hutt River south of Gregory Springs (site 5) in summer (but not spring) and Utcha Swamp (site 14). Utcha Swamp had particularly high percentage of HCO_3^- (18 to 23%) which, combined with the relatively high percentage of Ca^{2+} (14 to18%), probably reflects the limestone geology of the underlying aquifer (Arakel & Moulton 1986). Sulfate contributed relatively strongly (13–14 %) to anion composition at Yerina Spring (site 11), Utcha Swamp (site 14) and the sedge flats north of Hutt Lagoon (site 15).

Most sites had chlorophyll concentrations between 2 and 11 μg/L, the exceptions being Feast Soak (site 8) with 43.5 μg/L and Hutt River downstream of Yarder Gully confluence (site 3A) with 32 μg/L in summer (3.5 μg/L in spring). The other two sites which were sampled in both seasons had lower total chlorophyll concentrations in summer than in spring. Site 3A was also the only one of the three sites sampled in both seasons to have higher nitrogen concentration in summer. Nitrogen concentrations were mostly 300–900 μg/L, a few sites had 1000–1500 μg/L and three sites had nitrogen concentrations above 2000 μg/L (sites 3B, 11 and 12B). Site 3B also had 130 μg/L of phosphorus whereas phosphorus concentrations at the remaining sites were less than 50 μg/L.

Invertebrate diversity

A total of 219 taxa were collected in the 2007/08 survey, bringing the total number of taxa from all sampling to 249 (Appendix 1). Most species (155) were insects, over half of which (85) were dipterans. Fifty species were crustaceans, primarily ostracods and copepods, with oligochaetes (12 species) and rotifers (14 species) the richest of the remaining groups. Richness in a sample varied from 10 in Hutt Lagoon in 1999 to 62 in Yerina Spring in 1999 and averaged 38.9 ± 2.7. Thirty-eight percent of species were recorded only in one sample, 69% were recorded in 3 or fewer samples and only 5% were present in more than half of the samples.

The Chao2 species richness estimator suggests regional richness is likely to be about 343 species (95% C.I. 304–410), suggesting the survey effort to date may have collected about two-thirds of the species present in the sampled wetlands. In the three sites sampled in both spring and summer, only about a third of species collected at each site occurred in both seasons. Sites 3A and 4 had almost the same richness in summer as in spring but in site 5 summer richness was lower than in spring. Of the 87 species that occurred in any of the four summer samples (above sites plus 3C) 16 were not recorded at any sites in spring, but most of these were singletons and not likely to be associated with summer conditions in particular.

Invertebrate communities

The agglomerative clustering using average, complete and flexible linkage produced similarly structured dendrograms. The Hutt Lagoon samples (from sites 12A–D) always grouped together; sometimes with the sample from site 15 (the sedge flats north of Hutt Lagoon). Otherwise site 15 grouped with samples from sites 13 and 14 (which otherwise always formed a group on their own), usually as a sister group to the samples from sites 7 and 8. Remaining sites (all from the Hutt River catchment) generally formed two groups, one comprising samples from the main channel of the Hutt River (samples from sites 3A, 3C, 4, 5 and 6) and one with samples from the springs, spring-fed tributaries and the granite rock pools (from sites 1, 2, 3B, 9, 10 and 11). The first of these groups split into a group consisting of all of the samples collected in summer and one with all of the samples collected in spring. The sample from site 16 always clustered separately from other samples. The main deviation from the above clustering was that the average linkage method did not so clearly separate samples from the Hutt River channel from those of the springs and tributaries. Co-phenetic correlations for these dendrograms were between 0.86 and 0.92 suggesting that they represented original inter-sample distances very well. Simprof analyses suggested that all of the above groupings were significant. In the k-means (non-hierarchical) cluster analysis, the four Hutt Lagoon samples split into two groups: one with the two 2007 samples and one with the samples from 2008 and 1999. Samples from sites 13, 14 and 15 grouped together (as in some of the hierarchical analyses) but grouping of the Hutt River catchment samples did not neatly separate main channel from spring/tributary samples (as in the average linkage method). All samples from the main Hutt River channel sites grouped together, but this group included all three samples from Yarder Gully (sites 1, 2 and 16) and the 1999 sample from Yerina Spring (site 11). The remaining springs and tributaries formed two groups: samples from sites 7, 8 and 3B forming one group and those from sites 9, 10 and the 2007 sample from site 11 forming another. Based on these analyses we suggest six groupings of samples. In the descriptions of sample groups below, a species is considered to be strongly associated with the group if it occurred in more than half of the samples in the group and was twice as likely to be represented in the group as would be expected by chance.

GROUP 1 FRESHWATER SPRINGS AND SPRING-FED CREEK

This group consists of seven samples, all from springs, spring-fed creeks or seepages (sites 1, 2, 3B, 9, 10 and 11), although only site 10 had significant flow at the time of sampling. Most sites in this group were fresh (< 2.6 g/L) but TDS at site 3B was 8.8 g/L. Water chemistry at site 3B was measured in a rock pool close to the river which possibly filled with hyposaline river water prior to sampling, whereas invertebrates were also collected from higher elevation pools filled from fresh bank-seepage. The fauna at this site seems to be a combination of salt-tolerant and salt-sensitive taxa, giving this site particularly high richness (60 taxa). That this site clustered with the more saline seepages (sites 7 and 8 in group 4) in some analyses indicates the duplex nature of its fauna. A total of 151 species were recorded from these samples (average 47 ± 4.2/sample), of which 47 were not found in samples from other cluster groups. Most of the latter were singleton records so their occurrence only in this group is perhaps a matter of chance, but some are species that tend to be associated with freshwater springs, swamps and seepages, such as the mosquito *Culiseta atra*, beetle *Helochares tenuistriatus* and dragonflies *Nannophya occidentalis, Archaeosynthemis occidentalis* and *Orthetrum pruinosum migratum*. Species strongly and disproportionately represented in these samples were the copepod *Paracyclops chiltoni*, odonates *Adversaeshna brevistyla* and *Ischnura aurora* and chironomids *Polypedilum* nr *convexum, Paralimnophyes pullulus, Paramerina levidensis, Cricotopus albitarsus* and *Alotanypus dalyupensis*.

GROUP 2 HUTT RIVER CHANNEL

This group comprises all eight samples from the main channel of the Hutt River (sites 3A, 3C, 4, 5 and 6), though in some of the cluster analyses these were not clearly separated from samples in group 1. These sites were characterised by having flow in spring (but not in summer) and fresh to mildly hyposaline water (1.1–6.7 g/L, average 3.4). Total filterable nitrogen also tended to be lowest at these sites (mostly <600 ug/L). Samples from these sites contained 129 species, of which 32 (mostly singletons) occurred only in these sites. Average richness was 46 ± 2.7. Numerous species were strongly associated with this group, including the mayfly *Tasmanocoenis tillyardi*, gyrinid beetles, the blackfly *Simulium ornatipes*, ceratopogonids *Bezzia* spp. and *Monohelea* sp. 1, chironomids *Rheotanytarsus* sp., *Cladopelma curtivalva* and *Cryptochironomus grisiedorsum*, the caddisflies *Cheumatopsyche* AV2, *Oxyethira* sp. and *Acritoptila* sp. and the copepod *Onychocamptus bengalensis*. Many of these species are characteristic of flowing (or at least lotic) and/or hyposaline water. Some cluster analyses indicated that the four samples collected in late summer 2008 had a different composition from those collected in spring, but it is difficult to identify individual species responsible for this. *Thienemanniella* and *Harrisius* chironomids were present in four or five samples collected in spring but were absent in summer. By contrast, the copepods *Mesocyclops brooksi* and *Onychocamptus bengalensis* were much more common in summer. Such differential occurrences probably reflect the fact that all samples were collected in flowing water during spring but in still water in summer. Salinities were about the same in both seasons.

GROUP 3 SITE 16 (LOWER YARDER GULLY SAMPLED IN 1999)

This sample consistently fell out as a sister sample to groups 1 and 2. The site was fresh (1.3 g/L) and flowing when sampled. Only five of the 38 species present were not collected in any other samples. These were the oligochaetes *Insulodrilus* cf. *lacustris* and *Dero furcata*, ostracod *Candonopsis tenuis* and chironomids *Ablabesmyia notabilis*, and Orthocladiinae 'SO3' sp. A, i.e. all species that tend to be associated with freshwater. This site clustered with groups 1 and 2 because it shared many of the freshwater and flowing water species with samples in those groups. However, this sample lacked a number of dipteran species that were very common in samples of groups 1 and 2 (*Chironomus* aff. *alternans, Procladius paludicola, Paramerina levidensis Tanytarsus fuscithorax/semibarbitarsus*, and *Culicoides* sp.).

GROUP 4 SUB-SALINE SEEPAGES

This group consists of the two samples from Gregory Spring (site 7) and Feast Soak (site 8). These sites were shallow (~5 cm), hyposaline (4.5 and 8 g/L) and had higher chlorophyll (10.5 and 43.5 μg/L respectively) than all other sites except for 3B. Silica concentrations were also comparatively high (110 and 95 mg/L). These samples had 41 and 32 species respectively (58 combined), with only 15 collected from both. Species occurring in both sites but not present in other samples were the ostracods *Heterocypris* sp. and *Bennelongia* sp. 4, the copepods *Metacyclops* sp. 434 and the mosquito *Culex globocoxitus*. Other species of particular note are an undescribed *Austrotrombella* water mite (known only from a few other northern Wheatbelt sites), a possibly new *Arrenurus* water mite and some other taxa whose distributions are uncertain but which have rarely been recorded in the mid-west or Wheatbelt, such as Orthocladiinae sp. A, *Culex* sp. 3 and *Anopheles atratipes*.

GROUP 5 LOW SALINITY WETLANDS NORTH OF HUTT LAGOON

This group consists of all samples from the fresh to hyposaline wetlands in the Hutt Lagoon Catchment (sites 13 to 15). Utcha Swamp was fresh (1.8 in 1999 and 1.6 g/L in 2007) whereas sites 13 and 15 were hyposaline (4.7 and 8.8 g/L). These samples contained 81 species (27–45 per sample), including a number of widespread species which were present in three or four of these samples but otherwise comparatively rare. The latter were the chironomids *Dicrotendipes conjunctus* and *Procladius villosimanus*, the beetle *Hyphydrus elegans*, hemipterans *Agraptocorixa eurynome* and *Anisops elstoni* and the ostracod *Kennethia cristata*. These tend to occupy lentic rather than lotic habitats.

GROUP 6 HUTT LAGOON SITES

This group consists of the four Hutt Lagoon samples from sites 12A–D. Thirty-two species were present in these samples and sample richness varied between 10 and 18. Composition was highly variable, with only three species present in more than two samples (*Austrochiltonia* *subtenuis*, *Artemia* sp. and *Tanytarsus barbitarsus*). These four samples were from the highest salinity sites, although 12A (seepage area on the edge of the lagoon) had much lower salinity (15 g/L) than the main lagoon (sites 12B–D with salinity 180 to 320 g/L).

SUMMARY

In a three-dimensional nMDS ordination (Figure 2) these six groups of samples are reasonably well separated from each other. Group 6 (Hutt Lagoon samples) are well separated from the remaining (fresh to hyposaline) samples and groups 5 and 6 (all Hutt Lagoon catchment samples) are more dispersed in the ordination than the other groups, reflecting their more heterogeneous composition. Remaining groups are in close proximity but with little or no overlap.

Complementarity

A premise of the Walshe *et al.* (2004) analysis was that the catchments selected would be complementary in terms of their biodiversity assets. This was tested in a 2D ordination (stress = 0.19) of invertebrate communities from the Hutt wetlands and wetlands in most of the Recovery Catchments (Bryde, Drummond, Toolibin, Buntine–Marchagee and Warden). The Muir–Unicup Recovery Catchment has also been surveyed for invertebrates but the data are not yet available: however, considering its position in the higher rainfall southwest, that catchment is likely to have a very different fauna to the other catchments. After removing or merging taxa to make the datasets compatible, a total of 419 taxa remained. In the ordination (Figure 3) the Hutt samples occupied areas adjacent to, but mostly not overlapping, samples from the other catchments. This indicates that the Hutt catchments support an invertebrate fauna not represented in the other catchments. The clear exception is Hutt Lagoon (the four red dots towards the right in Figure 3) which were positioned in the same area as the largely saline Buntine–Marchagee wetlands. The similarity between Hutt Lagoon and the saline Buntine–Marchagee communities was probably due to shared presence of a few common halophilic species such as *Artemia* and *Australocypris insularis*. Some of the other catchments seem to overlap with one another in Figure 3 but in a 3D ordination (not shown) all are reasonably well separated. A Permanova analysis (to test whether the Hutt fauna differed from the faunas of other recovery catchment) was not performed because the data from different catchments are unequally dispersed within ordination space (tested using Permdisp in Primer).

DISCUSSION

Invertebrate diversity and composition

The invertebrate richness estimated for the region by the Chao2 estimator (about 340 species) suggests the survey effort to date has revealed about 73% of the aquatic invertebrate fauna potentially inhabiting the particular wetlands sampled in the region. This is on par with other aquatic invertebrate survey projects in Western Australia (Pinder *et al.* 2004, 2010a). Further survey effort would help to describe invertebrate diversity and habitat associations more thoroughly in these catchments,

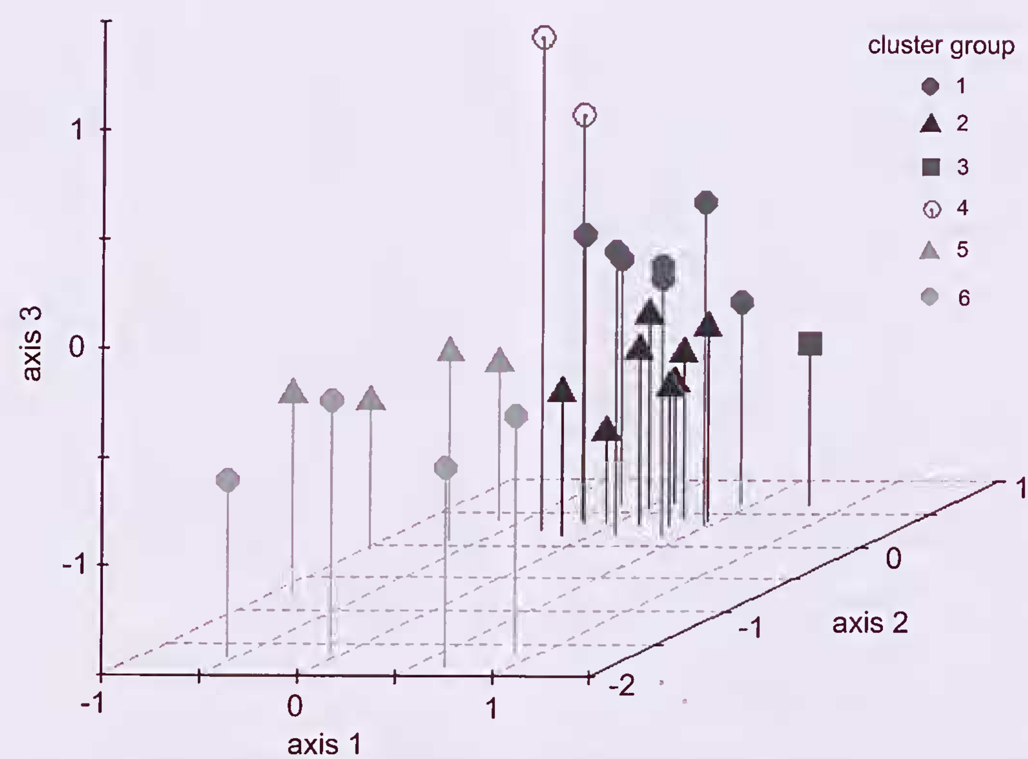

Figure 2. Three-dimensional nMDS ordination (stress = 0.1) of wetlands based on aquatic invertebrate community composition, showing the six groups derived from the cluster analysis.

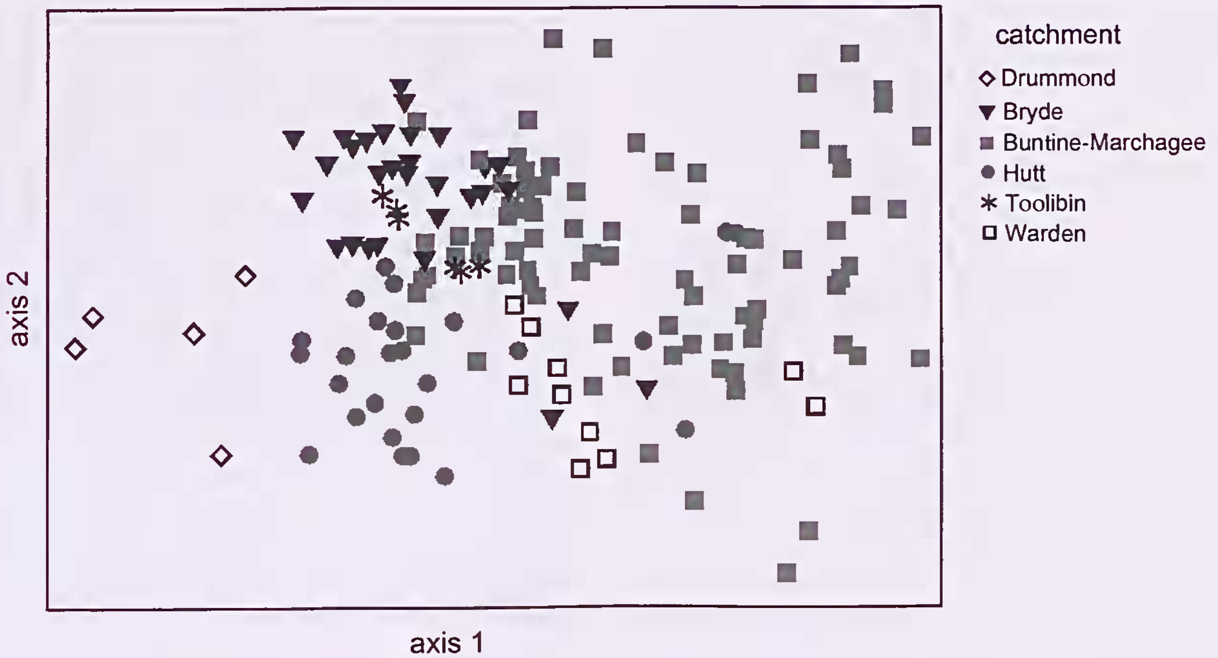

Figure 3. Two-dimensional nMDS ordination (stress = 0.19) of wetlands from the Hutt catchments and Natural Diversity Recovery Catchments based on aquatic invertebrate community composition.

particularly if the sampling gaps are filled. That most species occurred infrequently probably reflects the wide range of wetland types compared to the number of sites sampled.

The 249 taxa collected from the Hutt catchments is about a fifth of the total number of species collected from the Wheatbelt region (Cale *et al.* 2004; Jones *et al.* 2009; Pinder *et al.* 2004 and unpublished data). The average richness per sample in the Hutt catchments (38.9) was very similar to the average richness (40.1) for all Wheatbelt wetlands sampled by Pinder *et al.* (2004). However, richness is strongly correlated with salinity in the Wheatbelt region (Pinder *et al.* 2005), so comparisons of richness need to take that into account. When plotted against salinity, sample richness in the Hutt catchments' fresh and hyposaline wetlands appears somewhat lower than would be predicted from salinity alone (Figure 4). This may have been because many of the freshwater sites were small springs, seepages and creeks which tend to have lower richness (for a given salinity) than the larger lentic wetlands that predominate in the Wheatbelt survey dataset.

The catchment and sample richness for the Hutt is similar to that recorded in some other small catchments in the inland southwest that have been sampled using comparable methods and taxonomic scope and

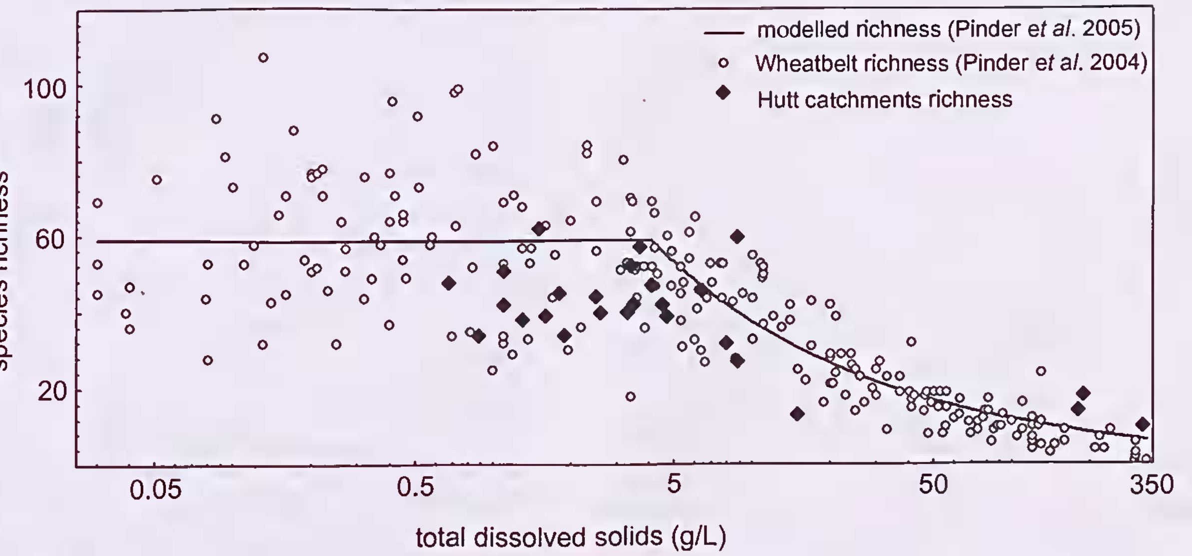

Figure 4. Total dissolved solids *vs* richness of aquatic invertebrate communities in Hutt wetlands and in wetlands sampled for the biological survey of the Southwest Agricultural Zone (Pinder *et al.* 2004), with the richness-salinity model from Pinder *et al.* (2005).

resolution. Cale (2008) and Cale *et al.* (2004), supplemented by unpublished data held by the Department of Environment & Conservation (DEC), recorded 240 taxa in 29 samples from seven mostly hyposaline to saline wetlands in the Lake Bryde Recovery Catchment. The average richness per sample in those wetlands was 42 ± 2.5, about the same as that in samples of the Hutt catchments.

In 21 wetlands in the Buntine–Marchagee Recovery Catchment (Aquatic Research Laboratory 2009 and reports therein) collected 223 taxa in 87 samples collected over five years. Average richness was only 20 ± 1.4/ sample but these wetlands were almost all saline. Species in common with the Hutt catchments were mostly very widespread and salt-tolerant, but include *Polypedilum leei*, a northern element (see Biogeography below) and *Limnocythere porphretica*, which is widespread in the southwest and Carnarvon Basin (Halse *et al.* 2000a) but uncommon compared to its congeners.

Several freshwater springs at the headwaters of the Arrowsmith River in the northern Wheatbelt, supporting a listed threatened ecological community (Rees & Broun 2005), were sampled by Pinder& Leung (2010 and reports therein). These have at least 176 species, with an average richness of 37 ± 4 per spring. Species in common between these springs and the Hutt catchments include some that are relatively rare in the Wheatbelt and tend to be found primarily in fresh and permanently moist habitats, such as the mosquitoes *Culiseta atra* and *Anopheles atratipes*, odonates *Archaeosynthemis occidentalis* and *Archiargiolests pusillus* and the water mite *Austrotrombella* n. sp.

Further south, the Muir–Unicup Recovery Catchment has a much richer fauna of around 400 species [unpubl. data from DEC, A Storey (University of Western Australia) and R Sheil (University of Adelaide)] but this higher richness reflects the much larger number of wetlands sampled (53) and that most of them are fresh. Average sample richness was about 47 species (Storey 1998). Unlike other recovery catchments, the Muir–Unicup fauna would include most of those species listed above as 'southwest' species whose Hutt populations are northern outliers.

Virtually all of the Hutt catchments' species are known from elsewhere (see Biogeography below) and it is unlikely that any are locally endemic. Between 21 and 36% of the Hutt catchments' fauna were present in each of the catchments mentioned above and at least 77% of the Hutt fauna occurs within one or more of them. However, this is based solely on presence/absence and would be true of almost all other catchments with a similar range of aquatic habitats in the southwest. Simple comparisons of species lists do not account for different probabilities of occurrence across landscapes. Our results indicate that aquatic invertebrate communities occurring in individual Hutt catchment wetlands are dissimilar in composition to those in established recovery catchments. Management of the Hutt wetlands for conservation would therefore be likely to protect a fauna that would not be as well represented elsewhere in the agricultural southwest.

The Walshe *et al.* (2004) analysis used aquatic species assemblages (waterbirds, aquatic invertebrates and aquatic flora) identified by Halse *et al.*(2004). The analysis suggested that assemblages 2 and 4 of Halse *et al.* (2004) were likely to be particularly well represented in the Hutt catchments but under-represented across the selected catchments overall, compared to species richness targets. Assemblage 2 included 54 invertebrate species found mostly in association with hyposaline water. Of these, 23 have now been recorded in the Hutt catchments. Average richness of assemblage 2 across the wider Wheatbelt (from the Wheatbelt survey excluding Hutt sites) was 1.5 ± 2 per sample whereas in the Hutt catchments there were 3.3 ± 0.5. Assemblage 4 included 38 invertebrates associated with fresh to hyposaline flowing water, especially in sites along the eastern slopes of the Darling Range. Of these, 14 have now been recorded in Hutt wetlands. Average richness of assemblage 4 across the wider Wheatbelt was 1 ± 0.2 per sample, whereas in the Hutt catchments there were 2.5 ± 0.5 per sample. These figures confirm that assemblages 2 and 4 are better represented in Hutt wetlands than in the wider Wheatbelt, but this was not the case for any of the other Halse *et al.* (2004) assemblages.

Biogeography

Most species recorded in the Hutt catchments are common in southwestern or southern Australia or even continentally, but some are southwest endemics and others have primarily northern and/or inland distributions.

A few of the species that are endemic to the southwest are much more commonly encountered in higher rainfall parts of the region and appear to be rare north of Perth. These are listed in Table 3, which also has notes on other northern records and wider distributions. Their occurrence in the Hutt River catchment is probably facilitated by the presence of permanent low-salinity water provided by the springs. Most of these, and numerous additional species with similar patterns of distribution, have been collected in fresh, permanently moist, organic mound springs near the town of Three Springs, 200 km north-northeast of Perth (Pinder & Leung 2010). Such species have been absent from other wetlands surveyed in the northern Wheatbelt and Mid-west (Aquatic Research Laboratory 2009; Jones *et al.* 2009), including from fresh to mildly saline springs near Jurien sampled by Pinder & Quinlan (2012). This highlights the importance of the Three Springs and Hutt River springs in maintaining this component of aquatic diversity in the Mid-west.

Numerous species have primarily northern Australian distributions, some of which have not previously been recorded this far south and probably close to their southern limits in the Hutt catchments (Table 3). These mainly occurred in wetlands of the Hutt Lagoon catchment (in contrast to the southern endemics which primarily occurred in the Hutt River catchment). An additional 27 northern or northern/inland species were recorded by Pinder *et al.* (2004) in the Eneabba to Murchison River region. These were mostly rotifers such as *Lecane aculeata*, *Lecane papuana* and *Trichocerca chattoni* or beetles such as *Batrachomatus wingi* and *Hydrochus lateviridus*. Others included the mosquito *Culex palpalis*, ostracod *Zonocypretta kalimna* and dragonfly *Austrogomphus gordoni*.

Table 3 Occurrence of southwestern endemic species and northern Australian species collected in Hutt wetlands

	Species	Occurrence in the present survey	Habitat and distribution
Southwestern endemic species			
Aquatic earthworms	*Ainudrilus nharna*	sites 4 & 10	A mildly salt tolerant species common in the south-west, including the southern and central Wheatbelt (Cale *et al.* 2004; Pinder *et al.* 2004), Only other records north of Toodyay are claypans in Drummond Nature Reserve (Cale 2005).
Mosquitoes	*Culiseta atra* and *Anopheles atratipes*	sites 1 & 7	Tend to inhabit permanent coloured freshwater swamps with decaying leaf litter (Liehne 1991). Rarely recorded north of Perth. Both also recorded at organic mound springs south-west of Three Springs (Pinder & Leung 2010).
Dragonflies	*Archaeosynthemis occidentalis*	site 1	Moderately common in permanent freshwater streams and wetlands south of Perth (Sutcliffe 2003). Also recorded in the Three Springs mound springs (Pinder & Leung 2010).
	Nannophya dalei	site 11	Inhabits boggy freshwater seepages and swamps of the south-west and appears to be rare even south of Perth (Sutcliffe 2003).
Diptera	Orthocladinae 'DEC sp. I'	sites 1, 8 & 11	Rare, in fresh to slightly saline swamps in the south-west. Otherwise only known from Three Springs mound springs in the mid-west (Pinder & Leung 2010).
	Harrissius sp.	sites 2, 3A, 4, 5 and 9	*Harrisius* are common in streams and rivers of the Darling Range and further south. Otherwise only known from Three Springs mound springs in the mid-west (Pinder & Leung 2010).
	Tanytarsus palmatus	sites 1,2,5 & 11	Widespread in streams in the south-west.
Northern species			
Beetles	*Megaporus ruficeps*	site 3B	Common in wetlands and rivers across northern Australia, but not recorded in southern Carnarvon Basin by Halse *et al.* (2000). Also recorded in a spring near Jurien (Pinder & Quinlan 2012).
	Neohydrocoptus subfasciatus	site 14	Common in wetlands and rivers across northern Australia but not recorded in southern Carnarvon Basin by Halse *et al.* (2000).
	Hydroglyphus leai	sites 12A & 13	Common in wetlands and rivers across northern Australia extending into the southern Carnarvon Basin (Halse *et al.* 2000) and mid-west (Daniel *et al.* 2009).
Water bugs	*Anisops nasuta*	site 13	Common in wetlands and rivers across northern and inland Australia, including the Carnarvon Basin, but rare further south. Also recorded in a spring near Jurien (Pinder & Quinlan 2012).
	Laccotrephes tristis	sites 1 & 5	Common in wetlands and rivers across northern Australia but rarely collected in south-western Australia. Not recorded in southern Carnarvon Basin by Halse et al. (2000).
	Paraplea sp.	sites 13 & 14	Probably an undescribed species common at least in north-western Australia. Pleids uncommon in southern Western Australia but a few records listed by Aquatic Research Laboratory (2009) and Pinder *et al.* (2004).
Dragonflies	*Orthetrum pruinosum migratum*	site 1	Common in wetlands (especially springs) across northern Australia but not recorded in southern Carnarvon Basin by Halse *et al.* (2000).
Rotifers	*Lecane grandis*	site 12D	A northern Australian halophilic rotifer (R.J. Shiel, University of Adelaide pers. comm.), not recorded south of Hutt Lagoon in Western Australia.
Diptera	*Polypedilum leei*	site 5	A northern/inland chironomid (Cranston 2000) of wetlands and rivers that has been occasionally recorded in the Wheatbelt as far south as the Avon River, e.g. Aquatic Research Laboratory (2009) and Pinder (2009).

From a conservation perspective, there are two ways of considering the northern and southern species towards the edges of their ranges. It could be argued that populations of these species may be at the limits of their ecological tolerances and that their conservation is likely to be more efficiently achieved in regions with more optimal environmental conditions. Thus, the northern species are more likely to persist in the Pilbara, with less active conservation effort than might be required to preserve them on the edge of their range. An alternative view is that transitional zones might be important in allowing species to cope with climate-change through migration and so suitable habitat should be maintained at and beyond the edges of current ranges. Furthermore, populations on the extremes of species' ranges may have genetic divergence/cryptic speciation (Thompson & Rich 2011) and/or adaptive resilience (including to changes in climate) not developed in populations in more benign parts of their range (Sexton *et al.* 2009). In any case, maintaining regional diversity means addressing the conservation needs of these components of the fauna.

An aquatic bio-regionalisation of Western Australia is yet to be produced, although there are enough data accumulating to begin such an analysis. An analysis of Freshwater Ecoregions of the World (FEOW) divided Western Australia into five regions, largely based on aquatic vertebrate species distributions (Unmack 2001; http://www.feow.org). The 'South-western Australian' and 'Paleo' FEOWs are divided at about the Arrowsmith River, which is close to the boundary (about the Irwin River) of the Geraldton Hills and Lesueur Sandplain terrestrial IBRA subregions (Australian Government 2004). These rivers lie within the northwest coastal extent of a broad zone of transition between a mesic-adapted southwest biota and a xeric-adapted northern/inland biota (Hopper 1979). Along the southeastern edge of this zone, Stewart (2009) identified a biogeographic divide along the south coast of Western Australia, distinguishing invertebrate faunas of fresher western rivers from those of more saline eastern rivers. The co-occurrence of northern and southwestern invertebrate species highlights the lower mid-west region as a zone of aquatic faunal transition.

A few species are notable for their apparent rarity. The oligochaete *Pristina sima*, recorded at sites 3 and 11, has previously been collected only from a spring in the eastern Pilbara region of Western Australia and from Boomerang Cave and Ellen Brook Spring near Perth. An undescribed *Austrotrombella* water mite (one of only two in the genus) from site 7 has otherwise been collected only from two streams south of Geraldton (Pinder *et al.* 2004) and from the Three Springs mound springs (Pinder & Leung 2010). Other possibly rare or restricted species are informally named so it is difficult to identify records in other published studies. Thus, some of the dipterans (*Culex* 'DEC sp. 3', *Aedes* nr *camptorynchus* and *Forcipomyia* spp.), the water mite *Arrenurus* sp. 25 and the copepod *Nitocra* sp. 3 have rarely or never been collected in the many other DEC projects.

Three microcrustaceans of marine affinity (copepods Lourinidae sp. and *Robertsonina* sp. and the ostracod *Paradoxostoma* sp.) occurred in Hutt Lagoon and may be related to congeners found in Lake McLeod, another large coastal lagoon surveyed by Halse *et al.* (2000a) and Russell (2004). They have not otherwise been recorded in inland waters of Western Australia, though there are marine species of these genera known from Australia.

Three introduced species were recorded. *Cherax caini* (non-hairy marron) and *Cherax destructor* (yabbie) are both common in the lower Hutt River and *C. caini* was collected in Yarder Gully. *Artemia* brine shrimp are introduced and at least one species (*Artemia parthenogenetica*) is an invasive species in Australia, with the potential to replace native *Parartemia* species in some Australian salt lakes (McMaster *et al.* 2007). However, the unidentified *Artemia* in Hutt Lagoon has now been present for several decades and is unlikely to have further ecological effects *in situ*. There is no evidence that *Parartemia* were ever present.

Conservation

The main channel of the Hutt River retains significant riparian vegetation and a foreshore condition assessment reported moderate to good condition for most if its length (Department of Environment 2005). There is also significantly more uncleared land away from the channel in the lower to middle parts of the catchment than many other rivers in the region and sections of the lower to middle channel are also heavily vegetated. The riparian and in-stream vegetation contribute to aquatic invertebrate habitat diversity and a quarter of all species in Appendix 1 were collected only in the main channel of the Hutt River, so it has significant value in terms of maintaining diversity in the catchment. However, the river is secondarily saline and analyses by Pinder *et al.* (2005) suggested that many freshwater species would have disappeared from the river. Further salinisation is a major threat to the river and this could occur as a result of greater salt load from the upper catchment or through reduced dilution by the freshwater springs and spring-fed tributaries. Management of salinity in the eastern part of the Hutt River catchment is therefore likely to have significant benefits for the lower parts of the Hutt River. Concentrations of nitrates and total filterable phosphorus were below interim guideline values for southwestern Australian lowland rivers (ANZECC & ARMCANZ 2000) but are undoubtedly elevated compared to pre-European times. Total filterable nitrogen concentrations were comparatively high at sites 3A and 3B (1500 and 3600 µg/L respectively, above the guideline of 1200 µg/L for total nitrogen in southwest rivers) and these were associated with elevated chlorophyll concentrations (32 µg/L at site 3A in summer). The somewhat different composition of the fauna of the river when it is flowing (in spring) versus when it is present as standing pools, suggests the river's full invertebrate component requires a seasonal flow regime.

Springs and spring-fed creeks (sample groups 1, 3 and 4) play an important role in reducing salinities in the Hutt River, but they also have significant value in their own right as remaining freshwater habitats supporting species with limited tolerance to elevated salinity. It is in the springs and spring-fed tributaries of the Hutt River that most of the invertebrate diversity resides, including 60 species not found in other wetland types and most of the rarer species and those southwestern endemics whose Hutt populations are northern outliers. For the southwestern endemics, at least, these springs provide permanently moist freshwater refugia in a dry (and drying) region. For these reasons, maintaining water quality and flow in the springs should be a priority and would have further benefit to the Hutt River by ameliorating secondary salinity.

The Hutt Lagoon is one of only a few such coastal salt lakes (sometimes known as birridas) in Western Australia. Similar wetlands include the Leeman Lagoons 200 km south of the Hutt River (Susac *et al.* 2009), Lake McLeod near Carnarvon (Halse *et al.* 2000a) and Mandora Marsh east of Port Hedland (Storey *et al.* 2011), but these wetlands have quite different hydrogeochemistry and faunas. Other coastal lagoons further south in the State, such as the Yalgorup lakes and Leschenault Inlet have also very different biotas (DEC unpubl. data). Inland saline playas also seem to have very different faunas (Pinder *et al.* 2004; Timms 2009; Williams *et al.* 1998). The locally unique element of the Hutt Lagoon fauna is the few crustaceans of marine affinity, possibly shared with at least Lake McLeod. Hutt Lagoon is intermittently used by large numbers of migratory shorebirds, though the extent of this depends on availability of other wetlands in the northwest. Conservation management issues are the beta-carotene production ponds and an existing garnet mine northwest of the lagoon, but neither of these are much of a threat to the lagoon invertebrate fauna as currently managed.

The area to the north of Hutt Lagoon has a diverse suite of wetlands still in reasonable condition, such as Utcha Swamp (site 14) and the *Baumea*/*Cyperus* fringed swamp (site 13). Utcha Swamp could be considered a significant wetland in the region because it is a vegetated freshwater lentic wetland in an area where such waters are rare, although it is being taken over by *Typha domingensis*, significantly reducing the area of open water and submerged macrophytes and therefore invertebrate habitat diversity. Utcha Swamp was the only locality for the undescribed *Arrenurus* sp. 25 water mite and the northern beetle *Neohydrocoptus subfasciatus*, but otherwise these wetlands supported very few species not present in other wetlands in the catchments. Most of the fauna of these wetlands comprises very widespread species.

In summary, the Hutt catchments contain a variety of wetland types supporting an aquatic invertebrate fauna that is at least as rich as others that have been surveyed with similar intensity in the agricultural zone of southwestern Australia. Moreover, we suggest that efforts to manage these catchments for conservation would protect an element of the fauna not as well represented in other catchments intensively managed for conservation.

ACKNOWLEDGEMENTS

This project was facilitated by the Department of Environment and Conservation's (DEC) Natural Diversity Recovery Catchments program, via the Buntine Marchagee NDRC. Funding was provided by State and Australian Governments, and administered by the Northern Agricultural Catchments Council. Additional funds to assist in preparing this paper were provided by the State Salinity Strategy via DEC's Mid-west region. Thanks to Rowan Dawson from DEC's Geraldton Office and Margi Wier from Greening Australia for assisting with site selection and facilitating field work. Cara Francis identified the chironomids, Brian Timms (University of New South Wales) identified the brine shrimp and Russell Shiel (University of Adelaide) identified the cladocerans and rotifers. Andrew Storey (University of Western Australia) provided invertebrate data for Muir–Unicup wetlands. Stuart Halse (Bennelongia Pty Ltd) provided advice on ostracod identifications. Thanks to Leonie Box, Frank Mauger and Tracey Leach for allowing us access to their properties.

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Received 1 August 2011; accepted 19 March 2012

Appendix 1 Aquatic invertebrates collected from wetlands sampled in the Hutt catchments.

Taxon	Sample																									
	1 Sep 2007	2 Sep 2007	3A Feb 2008	3A Sep 2007	3B Sep 2007	3C Feb 2008	4 Feb 2008	4 Sep 2007	5 Feb 2008	5 Sep 2007	6 Sep 2007	7 Sep 2007	8 Sep 2007	9 Sep 2007	10 Sep 2007	11 Jul 1999	11 Sep 2007	12A Sep 2007	12B Sep 2007	12C Oct 2008	12D Jul 1999	13 Sep 2007	14 Jul 1999	14 Sep 2007	15 Sep 2007	16 Jul 1999
PROTOZOANS																										
Arcella sp. A	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Arcella sp. B	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcella sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Centropyxis aculeata	-	1	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Centropyxis sp.	-	1	-	1	-	1	-	1	-	1	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Centropyxis cf. *kahlii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Difflugia sp.	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
TURBELLARIANS																										
Turbellaria	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	1	
Nemertines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemertini	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
NEMATODES																										
Nematoda	-	-	-	-	-	-	1	-	-	-	-	1	1	-	1	1	-	-	-	-	1	1	1	-	-	1
ROTIFERS																										
Bdelloidea	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Brachionus plicatilis s.l.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Keratella procurva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Colurella adriatica	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Euchlanis deflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lecane bulla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lecane flexilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lecane grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Lecane hamata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lecane ludwigii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lecane luna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Lecane thalera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Lecane grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Tripleuchlanis plicata	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephalodella gibba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

MOLLUSCS																										
Plotiopsis sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Ferrissia sp.	1	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyptophysa cf. *gibbosa*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coxiella striatula		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
OLIGOCHAETES																										
Naididae (ex Tubificidae)	-	-	-	1	1	1	1	1	-	1	-	-	1	1	-	-	1	-	-	-	-	1	1	-	-	1
Naidinae (ex Naididae)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dero digitata	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Dero furcata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Allonais ranauana	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pristina aequiseta	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-
Pristina jenkinae	-	-	-	-	1	-	-	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Pristina cf. sima	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Chaetogaster diastrophus	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamothrix bavaricus	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ainudrilus nharna	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Insulodrilus lacustris s.l.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Enchytraeidae	-	-	-	-	1	-	1	1	-	-	-	1	1	-	-	1	1	-	-	-	-	-	1	-	-	1
WATER MITES																										
Hydrachna australica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Hydrachna sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrachna cf. approximata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Austrotrombella sp. nov.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arrenurus (Truncaturus) sp. 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Arrenurus sp. HUT008	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
BRINE SHRIMP																										
Artemia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-
CLADOCERANS																										
Alona rigidicaudis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Alona sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-
Alona cf. *rectangula novaezelandiae*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leydigia australis	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Armatalona macrocopa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Daphnia carinata	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simocephalus elizabethae	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Simocephalus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Macrothrix breviseta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Macrothrix cf. *breviseta*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnocythere mowbrayensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Limnocythere porphyretica	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Ilyocypris australiensis	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Taxon	Sample 1 Sep 2007	2 Sep 2007	3A Feb 2008	3A Sep 2007	3B Sep 2007	3C Feb 2008	4 Feb 2008	4 Sep 2007	5 Feb 2008	5 Sep 2007	6 Sep 2007	7 Sep 2007	8 Sep 2007	9 Sep 2007	10 Sep 2007	11 Jul 1999	11 Sep 2007	12A Sep 2007	12B Sep 2007	12C Oct 2008	12D Jul 1999	13 Sep 2007	14 Jul 1999	14 Sep 2007	15 Sep 2007	16 Jul 1999
Candonopsis tenuis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Alboa worooa	1	-	1	1	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-	-	1	1	1	1
Australocypris insularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Bennelongia sp. 4	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Candonocypris novaezelandiae	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	-	-	-	-	-	-	1	-	1
Cypretta baylyi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Cypretta sp.	-	-	-	1	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Diacypris spinosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-
Heterocypris sp.	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Mytilocypris mytiloides	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	1	-	-	1	-
Ilyodromus sp.	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sarscypridopsis aculeata	1	1	1	1	1	1	1	1	-	1	-	1	1	1	1	1	1	-	-	-	-	-	1	1	-	1
Kennethia cristata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-
Paradoxostoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
COPEPODS																										
Calamoecia clitellata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		1		-	-	-	-	-	-
Calamoecia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Microcyclops varicans	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metacyclops sp. 462	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Metacyclops sp. 434	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Australocyclops australis	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Halicyclops ambiguus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Macrocyclops albidus	1	1	-	-	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Mesocyclops brooksi	-	-	1	1	1	1	1	-	1	-	-	-	-	1	1	-	1	-	1	-	-	1	1	1	1	-
Mesocyclops sp.	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Eucyclops australiensis	1	1	-	-	-	1	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Paracyclops chiltoni	1	1	1	-	1	1	-	-	-	-	1	-	-	1	1	-	1	-	-	-	-	-	-	-	-	1
Paracyclops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Paracyclops sp 1 (cf. *timmsi*)	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
Onychocamptus bengalensis	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Robertsonia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Nitocra? reducta (sp. 5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Nitocra sp. 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Nitocra sp. 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-
Lourinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Harpacticoida sp. 2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AMPHIPODS																										
Austrochiltonia subtenuis	1	1	1	-	1	1	-	1	1	1	1	-	-	-	-	1	1	1	1	1	-	1	1	1	1	1
ISOPODS																										
Philosciidae	-	-	-	-	-	-	-	-	-	-	-	-	—	-	-	-	-	-	-	-	1	-	-	-	-	-
DECAPODS																										
Cherax destructor	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cherax caini	-	1	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
COLEOPTERANS																										
Haliplus fuscatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Haliplus gibbus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neohydrocoptus subfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Hyphydrus elegans	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
Hyphydrus sp.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Hydroglyphus leai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Limbodessus inornatus	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Allodessus bistrigatus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paroster sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Sternopriscus sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Necterosoma penicillatus	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-
Necterosoma darwini	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Necterosoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
Megaporus ruficeps	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megaporus sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Platynectes aenescens	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platynectes decempunctatus var *decempunctatus*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platynectes sp.	-	-	1	-	-	-	-	1	-	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	1
Rhantus suturalis	-	-	1	1	1	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhantus sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Eretes australis	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eretes sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onychohydrus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Dytiscidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Bidessini	-	-	-	-	1	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Macrogyrus angustatus	-	1	1	1	1	1	1	-	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Macrogyrus sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aulonogyrus strigosus	-	1	-	1	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gyrinidae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Berosus approximans	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
Berosus discolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Berosus sp.	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-
Helochares tenuistriatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Helochares tatei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Helochares sp.	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnoxenus zelandicus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Taxon	Sample																									
	1 Sep 2007	2 Sep 2007	3A Feb 2008	3A Sep 2007	3B Sep 2007	3C Feb 2008	4 Feb 2008	4 Sep 2007	5 Feb 2008	5 Sep 2007	6 Sep 2007	7 Sep 2007	8 Sep 2007	9 Sep 2007	10 Sep 2007	11 Jul 1999	11 Sep 2007	12A Sep 2007	12B Sep 2007	12C Oct 2008	12D Jul 1999	13 Sep 2007	14 Jul 1999	14 Sep 2007	15 Sep 2007	16 Jul 1999
Limnoxenus sp.	-	-	-	1	1	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Paracymus pygmaeus	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Paracymus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Hydrophilidae	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-
Ochthebius sp.	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staphylinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Scirtidae	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-	1	-	1	-
Limnichidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Brentidae	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Curculionidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DIPTERANS																										
Diptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Tipulidae type A	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipulidae type C	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipulidae type E	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipulidae type F	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Tipulidae type H	1	-	-	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anopheles annulipes s.l.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-
Anopheles atratipes	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anopheles sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aedes alboannulotus	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Aedes camptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Aedes cf. camptorhynchus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culiseta atra	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culex globocoxitus	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Culex (Culex) australicus	-	-	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Culex sp. 3	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Bezzia sp. 2	-	1	1	-	-	-	1	1	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Bezzia sp. 1	1	-	-	1	-	1	1	1	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Culicoides sp.	1	1	1	1	1	1	-	1	-	1	1	1	1	1	1	1	1	-	1	-	1	-	-	-	-	-
Monohelea sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Monohelea sp. 1	-	-	-	1	-	1	1	-	1	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Monohelea sp. 2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monohelea sp. 4	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Nilobezzia sp.	-	-	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atrichopogon sp. 2	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forcypomyia sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Forcypomyia sp. 2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Forcypomyia sp. 6	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Forcypomyia sp. 7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forcypomyia sp. 8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forcypomyia sp. 9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasyhelea sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Dasyheleinae	-	-	-	-	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabanidae	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-
Stratiomyidae	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	-	-
Empididae	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dolichopodidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Dolichopodidae sp. A	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sciomyzidae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Ephydridae sp. 2	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Ephydridae sp. 3	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae sp. 4	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae sp. 6	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	1	-	-	-
Ephydridae sp. 12	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae sp. 13	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muscidae	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muscidae sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Diptera sp. E	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Procladius paludicola	1	-	1	1	1	1	1	1	1	1	1	-	-	-	-	1	1	1	-	-	1	-	-	-	1	-
-*Procladius villosimanus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1
Alotanypus dalyupensis	-	1	-	-	1	1	-	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-
Ablabesmyia notabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Paramerina levidensis	-	1	-	1	1	-	-	1	1	1	1	1	-	1	1	1	1	-	-	-	-	-	1	1	-	-
Larsia albiceps	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parakiefferiella sp. A	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Nanocladius sp. 1 (VCD7)	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corynoneura sp.	1	-	-	-	1	-	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-	1	-	-
Corynoneura sp. (V49)	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-
Thienemanniella sp. (V19)	-	1	-	1	-	-	-	1	-	1	1	-	-	1	1	-	1	-	-	-	-	-	-	-	-	1
Paralimnophyes pullulus	1	1	-	1	1	-	-	-	-	1	1	1	1	1	1	1	1	-	-	-	-	1	-	-	-	-
Cricotopus albitarsus	1	1	-	1	-	1	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Paraimnophyes sp. A	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Orthocladiinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. A (?VSC11)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. I	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Orthocladiinae S03 sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Orthocladiinae sp. G	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Cladotanytarsus sp. A	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus barbitarsis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-
Tanytarsus palmatus	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Tanytarsus sp. C (*bispinosus*)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp. D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp. G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp. H	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Taxon	Sample																								
	1 Sep 2007	2 Sep 2007	3A Feb 2008	3A Sep 2007	3B Sep 2007	3C Feb 2008	4 Feb 2008	4 Sep 2007	5 Feb 2008	5 Sep 2007	6 Sep 2007	7 Sep 2007	8 Sep 2007	9 Sep 2007	10 Sep 2007	11 Jul 1999	11 Sep 2007	12A Sep 2007	12B Sep 2007	12C Oct 2008	12D Jul 1999	13 Sep 2007	14 Jul 1999	14 Sep 2007	15 Sep 2007	16 Jul 1999
Tanytarsus nr *bispinosus*	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus fuscithorax/ semibarbitarsus	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	1	1	1	-	-
Rheotanytarsus juliae	-	-	-	1	-	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rheotanytarsus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Kiefferulus intertinctus	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Polypedilum leei	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum nubifer	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	1	-	1	-	-
Polypedilum cf. *convexum*	-	1	1	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-
Paraborniella tonnoiri	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus griseidorsum	-	1	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladopelma curtivalva	-	-	1	-	-	1	1	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
EPHEMEROPTERANS																										
Baetidae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cloeon sp.	-	-	-1	1	1	1	-	-	1	1	-	-	-	1	1	1	-	-	-	-	-	-	1	1	-	1
Tasmanocoenis tillyardi	-	1	-	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
HEMIPTERANS																										
Hydrometra strigosa	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microvelia (Pacificovelia) oceanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Microvelia (Austromicrovelia) peramoena	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Microvelia sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Veliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-
Laccotrephes tristis	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agraptocorixa eurynome	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
Agraptocorixa sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Micronecta robusta	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Micronecta sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corixidae	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-
Anisops thienemanni	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-
Anisops elstoni	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
Anisops nasuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Anisops stali	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anisops sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Notonectidae	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-
Paraplea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Paraplea n. sp. (ANIC 6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

LEPIDOPTERANS																										
Lepidoptera sp.	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
Pyralidae sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyralidae cf. sp. 39/40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Lepidoptera (non-pyralid) sp. 3	1	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera (non-pyralid) Pilbara sp. 3	-	-	-	-	-	-	-	-	-	1	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
ODONATES																										
Epiproctophora (=Anisoptera) sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Austroagrion cyane	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Ischnura aurora aurora	1	-	-	-	1	-	-	-	1	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	-	-
Ischnura heterosticta heterosticta	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Austrolestes psyche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Archiargiolestes pusillus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Adversaeschna brevistyla	-	1	-	-	-	1	-	-	1	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-
Hemianax papuensis	-	-	-	1	1	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	1	1	1	1	-
Aeshnidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Corduliidae	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Diplacodes bipunctata	—	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Nannophya dalei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Orthetrum caledonicum	-	1	1	-	-	1	1	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-
Orthetrum pruinosum migratum	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Archaeosynthemis occidentalis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Hemicordulia australiae	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hemicordulia tau	-	1	1	1	1	-	1	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-	1	-	1
TRICHOPTERANS																										
Trichoptera sp.	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acritoptila globosa	-	-	-	1	-	1	1	1	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Hellyethira litua	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxyethira sp.	-	-	1	-	-	-	-	1	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Cheumatopsyche sp. AV2	-	-	-	1	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsychidae	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Ecnomus pansus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ecnomidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oecetis sp.	-	-	1	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Triplectides australis	-	-	-	1	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-